DOOSAN Document Transmittal

Upper Trishuli-1 HEP (216MW)

Date	DT No.:	SHEET
2022-06-06	UT1-HEP-DHI-PC-D-0033	1 OF 1

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SUBJECT	Submission of Review Note RN-0132, RN-0133 and RN-0134		

S. N.	REVIEW NOTE NO.	REVIEW STATUS	DWG. / DOC. NO.	REV.	DWG. TITLE / DOC. DESCRIPTION	REMARK
1	RN-0132	AN	UT1-C-090-CVL-DG-64002	0B	Excavation and Initial Support Drawings of Main Access Tunnel to Powerhouse	
2	RN-0133	AN	UT1-C-300-CVL-DC-60001	0B	Stability Calculations for the Surrounding Rock of Powerhouse Cavern	
3	RN-0134	RR	UT1-C-845-CVL-DG-70002	0A	Monitoring Layout Drawing of Underground Powerhouse and Transformer Cavern	
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Legend of Review Status
A : APPROVED
AN : APPROVED AS NOTED
RR : RETURN FOR RESUBMISSION
FI : FOR INFORMATION

DHI STAMP

Doosan Heavy Industries & Construction Co. Ltd. Branch Office Nepal
DOOSAN

Issued by DHI

for

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Doosan Heavy Industries & Construction Co., Ltd.

Discipline : Civil

UPPER TRISHULI-1 HEP (216MW)

Client	**Nepal Water and Energy Development Company Private Limited**
Owner's Engineer	**Tractebel Engineering GmbH / Jade Consult**

REVIEW NOTE

Contractor	**Doosan Enerbility**		
Title of the Document	Monitoring Layout Drawing of Underground Powerhouse and Transformer Cavern		
Document No.	UT1-C-845-CVL-DG-70002	Revision	0A
Date of Documents	02.06.2022	Received Date	03.06.2022
Transmittal Form No.	UT1-HEP-DHI-D-0255		
Previous Review Date/Status	N/A	Prev. Review Note No.	N/A
Review Note No.	**RN-0134**	**Present Review Date**	**05.06.2022**
		Present Review Status	**RR**

A: Approved AN: Approved as Noted RR: Returned for Resubmission FI: For Information, only

General Comments

A monitoring system for large underground excavations serves certain purposes, which must be addressed when setting up the system. During the excavation of the Powerhouse and the Transformer Hall, monitoring results are used to confirm/adjust in reality the selected support assumed for the FE-calculations. **The set-up of the monitoring system is therefore always directly coupled to the FE-calculation report (vice versa). In this case the monitoring system presented in the document in hand should have been coupled with (to the results of) Doc. No. UT1-C-300-CVL-DC-60001, *Stability Calculation for the Surrounding Rock of the Powerhouse Cavern*, dated 27.05.2022, vice versa, but this is not the case.**

In addition to monitoring displacements of rock mass and the support system, the increase of loads and stresses in rock reinforcement and shotcrete, and the development of water pressure in the rock mass must also be determined.

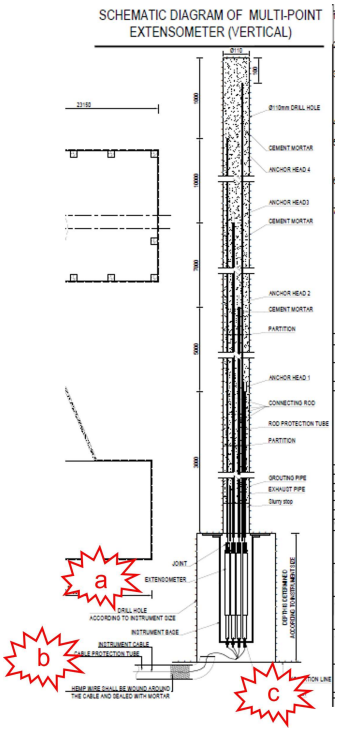
The suggested monitoring system is insufficient and not tailored to the project requirements. It even lacks basic components to determine loads/stresses in the support system. It purely addresses displacement monitoring with few extensometers and optical targets, which is commented further below. No monitoring of the face walls is suggested.

It is also essential to define in such monitoring drawings, when the instruments must be installed (= at which stage/advance) of the excavation process. This is highlighted when looking at the expected extensometer results for the crown of the Powerhouse cavern, which are presented in Doc. No. UT1-C-300-CVL-DC-60001, Figs. 6.3-1 to 6.3-4. The total displacements in the crown of the Powerhouse are expected to be at a maximum of a few millimetres, only, and they occur practically all during excavation of the Powerhouse Roof Section. This means that the respective extensometers in the crown must be installed before the side drifts in the crown section are opened. Otherwise, one would practically measure nil displacements (= during bench excavation) and the crown extensometers are wasted/useless. Similar considerations apply to the installation of load cells on rock bolt heads and in shotcrete, and strain gauges on bolts and dowels to measure load development in the bolts and dowels. **The suggested monitoring system needs to be completely revised prior to opening the Powerhouse Crown.**

In the following only comments on the displacement monitoring system can be given and the document is returned for resubmission.

Drawing No.: UT1-C-845-CVL-DG-70002 (sh. 1/3), version 0A

Face Walls (Eastern and Western Face Wall) will also require displacement monitoring. In the Eastern Face Wall extensometer installation at approx. El. 931 m, and monitoring with optical targets shall be defined. In the 40 m high Western Face Wall, extensometers need to be installed at approx. El. 931 and El. 918.



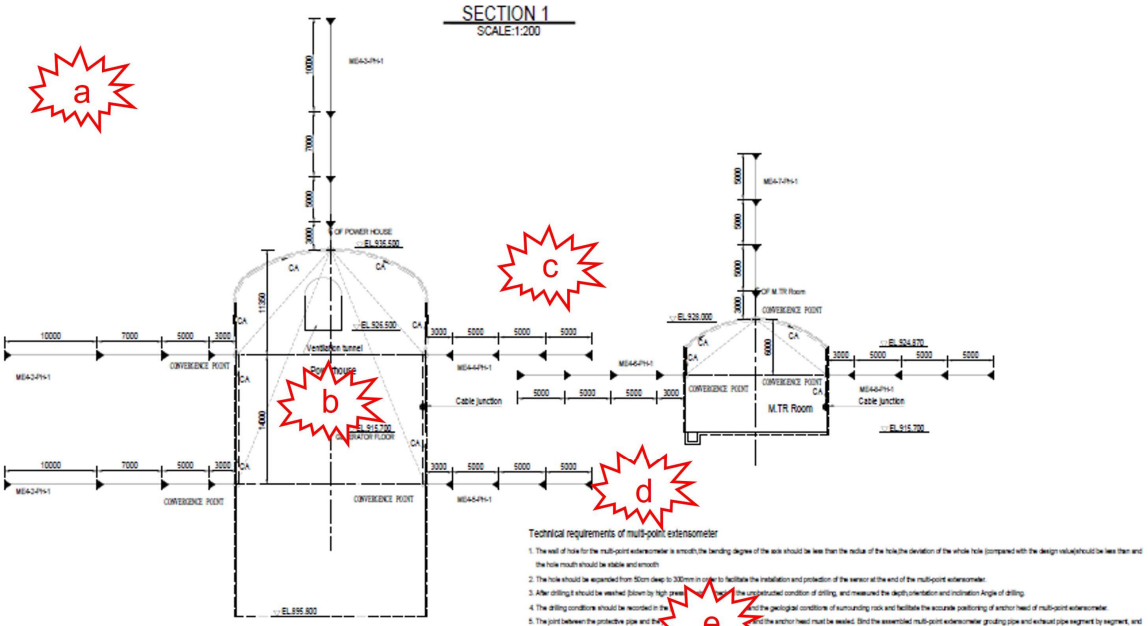
(a) Drill hole size for extensometer head as defined in text further below (300 x 500 mm). Revise.
(b) Cable shall be in thicker PVC pipe that is embedded in the shotcrete liner.
(c) Steel cap protection from fly-rock shall be provided. Revise.

NOTE

1. All dimensions are in millimeters, and coordinates, chainage and elevation are in meters unless otherwise stated in the drawing.
2. Layout of Underground powerhouse and Transformer cavern is subject to the drawing UT1-C-300-CVL-DG-60001.
3. Multi-point extensometer is applied to monitor deep deformation of rock mass,sections are selected as shown on the drawing, schematic diagram and relevant technical requirements of Multi-point extensometer is shown in drawing
4. Technical requirements of convergence monitoring, please see UT1-C-845-CVL-DG-70006.
5. Besides deep deformation & convergence measurement, other monitoring items can be carried out as per conditions and request of Employer or onsite QE during construction.
6. All cables are protected by steel pipes. Attention shall be paid to prevent cables from being damaged during construction.
7. The monitoring station of Underground powerhouse and Transformer cavern is arranged at generator floor at EL.915.70m

(a) Item 3 not needed.
(b) The referenced drawing refers to the Investigation Tunnel. Produce own drawing(s) for Powerhouse convergence monitoring with longitudinal/cross sections, number of targets etc.
(c) „Other monitoring items“ (= bolt/dowel stress, shotcrete stress, water pressure in rock mass) must be defined and the foreseen number/locations shown in drawings.
(d) All cables shall be protected with “thick and flexible” PVC/rubber pipes, which are embedded in the shotcrete liner. This provides protection and possible replacement.

Drawing No.: UT1-C-845-CVL-DG-70002 (sh. 2/3), version 0A



Technical requirements of multi-point extensometer

1. The wall of hole for the multi-point extensometer is smooth,the bending degree of the axis should be less than the radius of the hole,the deviation of the whole hole (compared with the design value)should be less than and the hole mouth should be stable and smooth
2. The hole should be expanded from 50cm deep to 300mm in order to facilitate the installation and protection of the sensor at the end of the multi-point extensometer.
3. After drilling,it should be washed (blown by high pressure wind),checked the unobstructed condition of drilling, and measured the depth,orientation and inclination Angle of drilling.
4. The drilling conditions should be recorded in the process of drilling to understand the geological conditions of surrounding rock and facilitate the accurate positioning of anchor head of multi-point extensometer.
5. The joint between the protective pipe and the joint between the protective pipe and the anchor head must be sealed. Bind the assembled multi-point extensometer grouting pipe and exhaust pipe segment by segment, and mark each meter of protective tube with colored adhesive tape, and then slowly feed into the hole. The grouting pipe of the vertical hole and the upward hole is at the mouth of the hole, and the exhaust pipe is at the bottom of the hole. The grouting pipe of the horizontal hole is at the lower part of the hole, and the exhaust pipe is at the upper part of the hole.
6. Backfill grouting should ensure full grouting of borehole. Grouting can be suspended after the exhaust pipe discharge thick slurry. Grouting can be done again after 15 minutes,and the grouting pipe will be tied to close the grouting after the exhaust pipe has discharged the thick slurry again.
7. 24 hours after the final grout setting, fix the sensor device, draw out the cable, install the protective cover and hole protection cover, and obtain the initial reading.
8. After installation, spray the instrument number on the concrete or rock near the measuring point with red paint.

OBSERVATION INSTRUMENT EQUIPMENT LIST

NO.	NAME	LEGEND	SYMBOL	QUANTITY	UNIT	REMARK
1	Multi-point extensometer		ME4	22	ST	Vibrating wire displacement transducer,Range 100mm,Resolution0.025%F.S.,Including sensor, connecting rod, rod protection tube, anchor head, partition plate, instrument base and other orifice devices.
2	Hole for rock Multi-point extensometer					Hole diameter ϕ110mm, single hole depth 25m or 19m,Including backfill grouting.
3	Cable for vibrating wire type		CA			6Pr, galvanized copper wire.
7	Convergent measuring point					The number of measuring points shall be calculated according to the monitoring section.
8	Hub box		B	5	Set	Allow access to 20 instruments,Protect with a homemade protective box.
9	Cable protection tube			460	m	50mm diameter galvanized steel pipe with wall thickness greater than 2.5mm.

(a) General arrangement of extensometers in section ok.
(b) Delete line for (tape) convergence measurements as optical targets are used.
(c) Orientation of this extensometer shall be 15° upward.
(d) Orientation of this extensometer shall be 15° upward toward floor of Transformer Hall..

Technical requirements of multi-point extensometer

1. The wall of hole for the multi-point extensometer is smooth,the bending degree of the axis should be less than the radius of the hole,the deviation of the whole hole (compared with the design value)should be less than and the hole mouth should be stable and smooth
2. The hole should be expanded from 50cm deep to 300mm in order to facilitate the installation and protection of the sensor at the end of the multi-point extensometer.
3. After drilling,it should be washed (blown by high pressure wind),checked the unobstructed condition of drilling, and measured the depth,orientation and inclination Angle of drilling.
4. The drilling conditions should be recorded in the process of drilling to understand the geological conditions of surrounding rock and facilitate the accurate positioning of anchor head of multi-point extensometer.
5. The joint between the protective pipe and the joint between the protective pipe and the anchor head must be sealed. Bind the assembled multi-point extensometer grouting pipe and exhaust pipe segment by segment, and mark each meter of protective tube with colored adhesive tape, and then slowly feed into the hole. The grouting pipe of the vertical hole and the upward hole is at the mouth of the hole, and the exhaust pipe is at the bottom of the hole. The grouting pipe of the horizontal hole is at the lower part of the hole, and the exhaust pipe is at the upper part of the hole.
6. Backfill grouting should ensure full grouting of borehole. Grouting can be suspended after the exhaust pipe discharge thick slurry. Grouting can be done again after 15 minutes,and the grouting pipe will be tied to close the grouting after the exhaust pipe has discharged the thick slurry again.
7. 24 hours after the final grout setting, fix the sensor device, draw out the cable, install the protective cover and hole protection cover, and obtain the initial reading.
8. After installation, spray the instrument number on the concrete or rock near the measuring point with red paint.

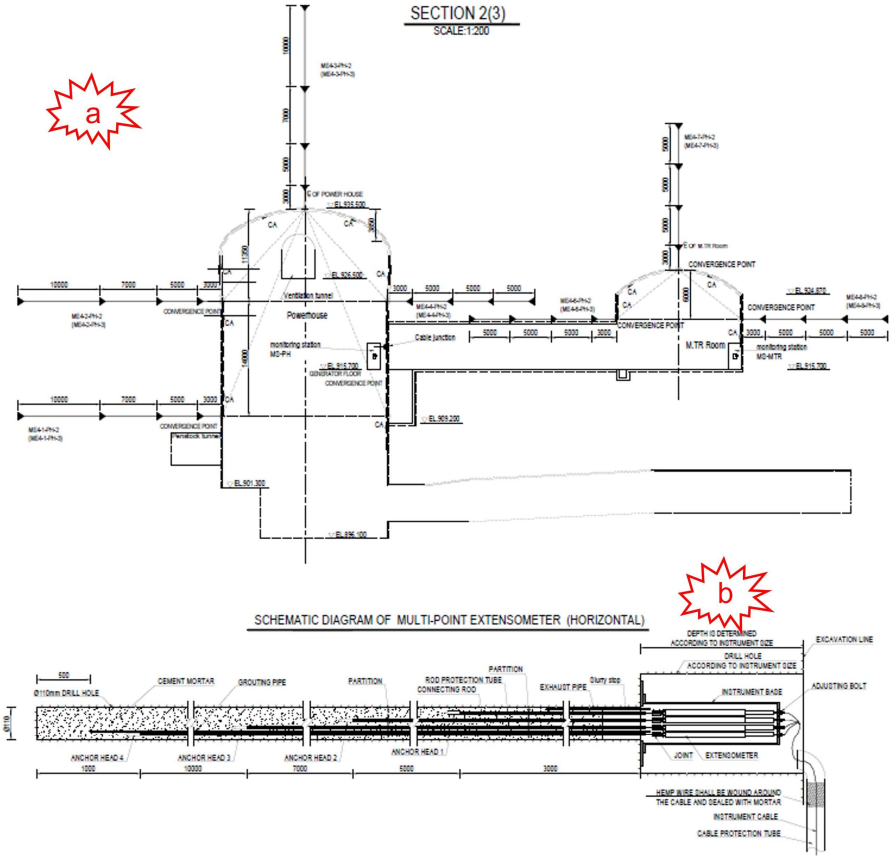
(a) Steel protective cap shall be addressed.
(b) How is orientation of the borehole measured? Briefly describe.
(c) By whom and how is this recorded? (by driller, engineer, geologist?)
(d) Specify w/c-ratio of grout.
(e) To confirm functionality of extensometer, a reading shall also be performed directly after grout setting, and initial (=zero) reading is 24 h after grouting.
(f) Refer to steel protective cap (see also (a)).

OBSERVATION INSTRUMENT EQUIPMENT LIST

NO.	NAME	LEGEND	SYMBOL	QUANTITY	UNIT	REMARK
1	Multi-point extensometer		ME4	22	SET	Vibrating wire displacement transducer,Range 100mm,Resolution0.025%F.S..Including sensor, connecting rod, rod protection tube, anchor head, partition plate, instrument base and other orifice devices.
2	Hole for rock Multi-point extensometer			523	m	Borehole diameter ϕ110mm, single hole depth 26m or 19m,including backfill grouting.
3	Cable for vibrating wire type		CA	1080	m	10 core, galvanized copper wire.
7	Convergent measuring point				set	The number of measuring points shall be calculated according to the monitoring section.
8	Hub box		B	5	set	Allow access to 20 instruments,Protect with a homemade protective box.
9	Cable protection tube			460	m	50mm diameter galvanized steel pipe with wall thickness greater than 2.5mm.

(a) Update table with new data and instrumentation details.
(b) Adjust all quantities to actual foreseen monitoring instruments as defined in the individual monitoring sections.
(c) Adjust number of data collection boxes to actual requirements.
(d) Consider using flexible pipes embedded in the shotcrete liner.

Drawing No.: UT1-C-845-CVL-DG-70002 (sh. 3/3), version 0A



(a) Comments apply similarly as for Drawing No.: UT1-C-845-CVL-DG-70002 (sh. 2/3), version 0A.
(b) Comments on extensometer apply similarly as for Drawing No.: UT1-C-845-CVL-DG-70002 (sh. 1/3), version 0A..

DISCLAIMER

Any approval will not release the Contractor from any of his obligations under the Contract.

Dr. U. Glawe